

# DATA SHEET



## **PMBT3904** NPN switching transistor

Product data sheet  
Supersedes data of 1999 Apr 27

2004 Jan 12

# NPN switching transistor

# PMBT3904

### FEATURES

- Collector current capability  $I_C = 200 \text{ mA}$
- Collector-emitter voltage  $V_{CEO} = 40 \text{ V}$ .

### APPLICATIONS

- General switching and amplification.

### DESCRIPTION

NPN switching transistor in a SOT23 plastic package.  
PNP complement: PMBT3906.

### MARKING

| TYPE NUMBER | MARKING CODE <sup>(1)</sup> |
|-------------|-----------------------------|
| PMBT3904    | *1A                         |

### Note

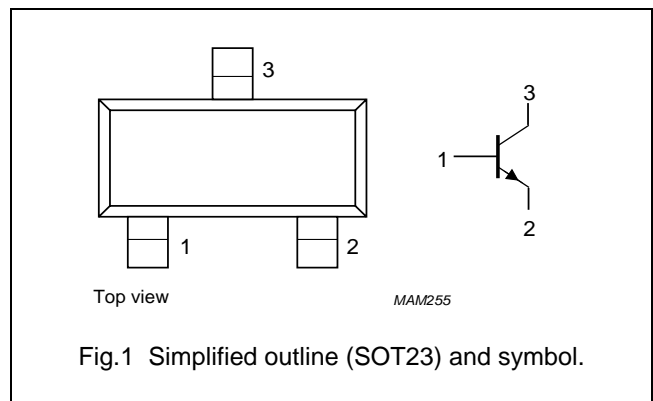
- \* = p : Made in Hong Kong.  
\* = t : Made in Malaysia.  
\* = W : Made in China.

### QUICK REFERENCE DATA

| SYMBOL    | PARAMETER                 | MAX. | UNIT |
|-----------|---------------------------|------|------|
| $V_{CEO}$ | collector-emitter voltage | 40   | V    |
| $I_C$     | collector current (DC)    | 200  | mA   |

### PINNING

| PIN | DESCRIPTION |
|-----|-------------|
| 1   | base        |
| 2   | emitter     |
| 3   | collector   |



### ORDERING INFORMATION

| TYPE NUMBER | PACKAGE |  |         |
|-------------|---------|--|---------|
|             | NAME    | DESCRIPTION                              | VERSION |
| PMBT3904    | -       | plastic surface mounted package; 3 leads | SOT23   |

## NPN switching transistor

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**LIMITING VALUES**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| SYMBOL    | PARAMETER                     | CONDITIONS                           | MIN. | MAX. | UNIT |
|-----------|-------------------------------|--------------------------------------|------|------|------|
| $V_{CBO}$ | collector-base voltage        | open emitter                         | –    | 60   | V    |
| $V_{CEO}$ | collector-emitter voltage     | open base                            | –    | 40   | V    |
| $V_{EBO}$ | emitter-base voltage          | open collector                       | –    | 6    | V    |
| $I_C$     | collector current (DC)        |                                      | –    | 200  | mA   |
| $I_{CM}$  | peak collector current        |                                      | –    | 200  | mA   |
| $I_{BM}$  | peak base current             |                                      | –    | 100  | mA   |
| $P_{tot}$ | total power dissipation       | $T_{amb} \leq 25\text{ °C}$ ; note 1 | –    | 250  | mW   |
| $T_{stg}$ | storage temperature           |                                      | –65  | +150 | °C   |
| $T_j$     | junction temperature          |                                      | –    | 150  | °C   |
| $T_{amb}$ | operating ambient temperature |                                      | –65  | +150 | °C   |

**Note**

1. Transistor mounted on an FR4 printed-circuit board.

**THERMAL CHARACTERISTICS**

| SYMBOL        | PARAMETER                                   | CONDITIONS | VALUE | UNIT |
|---------------|---|------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | note 1     | 500   | K/W  |

**Note**

1. Transistor mounted on an FR4 printed-circuit board.

**CHARACTERISTICS**

$T_{amb} = 25\text{ °C}$  unless otherwise specified.

| SYMBOL      | PARAMETER                            | CONDITIONS   | MIN.                        | MAX.                    | UNIT |
|-------------|--------------------------------------|--|-----------------------------|-------------------------|------|
| $I_{CBO}$   | collector cut-off current            | $I_E = 0$ ; $V_{CB} = 30\text{ V}$   | –                           | 50                      | nA   |
| $I_{EBO}$   | emitter cut-off current              | $I_C = 0$ ; $V_{EB} = 6\text{ V}$  | –                           | 50                      | nA   |
| $h_{FE}$    | DC current gain                      | $V_{CE} = 1\text{ V}$ ; see Fig.2; note 1<br>$I_C = 0.1\text{ mA}$<br>$I_C = 1\text{ mA}$<br>$I_C = 10\text{ mA}$<br>$I_C = 50\text{ mA}$<br>$I_C = 100\text{ mA}$ | 60<br>80<br>100<br>60<br>30 | –<br>–<br>300<br>–<br>– |      |
| $V_{CEsat}$ | collector-emitter saturation voltage | $I_C = 10\text{ mA}$ ; $I_B = 1\text{ mA}$   | –                           | 200                     | mV   |
|             |                                      | $I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$   | –                           | 300                     | mV   |
| $V_{BEsat}$ | base-emitter saturation voltage      | $I_C = 10\text{ mA}$ ; $I_B = 1\text{ mA}$   | 650                         | 850                     | mV   |
|             |                                      | $I_C = 50\text{ mA}$ ; $I_B = 5\text{ mA}$   | –                           | 950                     | mV   |
| $C_c$       | collector capacitance                | $I_E = I_e = 0$ ; $V_{CB} = 5\text{ V}$ ; $f = 1\text{ MHz}$   | –                           | 4                       | pF   |
| $C_e$       | emitter capacitance                  | $I_C = I_c = 0$ ; $V_{BE} = 500\text{ mV}$ ; $f = 1\text{ MHz}$  | –                           | 8                       | pF   |

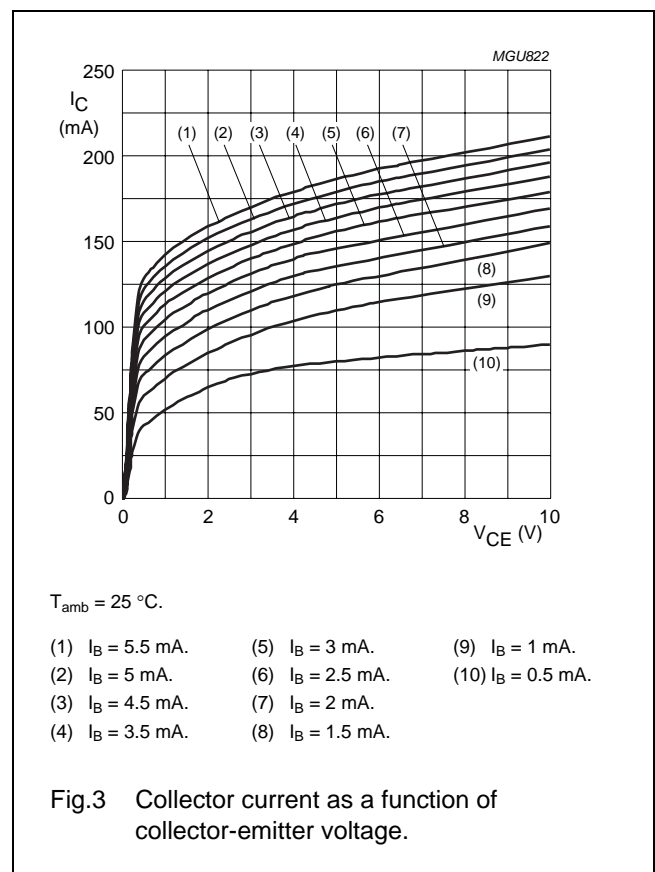
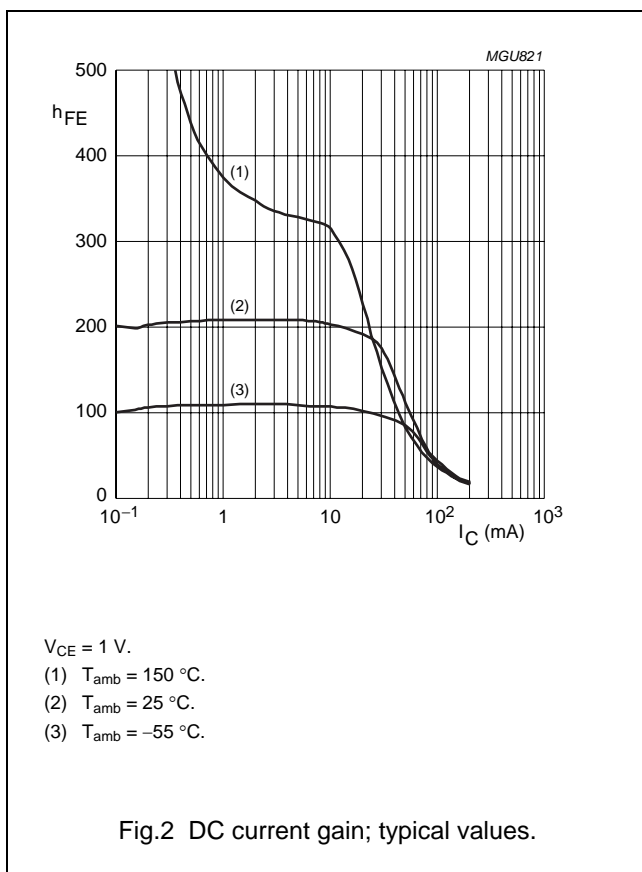
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| SYMBOL   | PARAMETER            | CONDITIONS  | MIN. | MAX. | UNIT |
|--|----------------------|---|------|------|------|
| $f_T$  | transition frequency | $I_C = 10 \text{ mA}; V_{CE} = 20 \text{ V};$<br>$f = 100 \text{ MHz}$  | 300  | –    | MHz  |
| F  | noise figure         | $I_C = 100 \mu\text{A}; V_{CE} = 5 \text{ V}; R_S = 1 \text{ k}\Omega;$<br>$f = 10 \text{ Hz to } 15.7 \text{ kHz}$ | –    | 5    | dB   |
| <b>Switching times (between 10% and 90% levels); see Fig.3</b> |                      |   |      |      |      |
| $t_d$  | delay time           | $I_{Con} = 10 \text{ mA}; I_{Bon} = 1 \text{ mA};$<br>$I_{Boff} = -1 \text{ mA}$                                    | –    | 35   | ns   |
| $t_r$  | rise time            |   | –    | 35   | ns   |
| $t_s$  | storage time         |   | –    | 200  | ns   |
| $t_f$  | fall time            |   | –    | 50   | ns   |

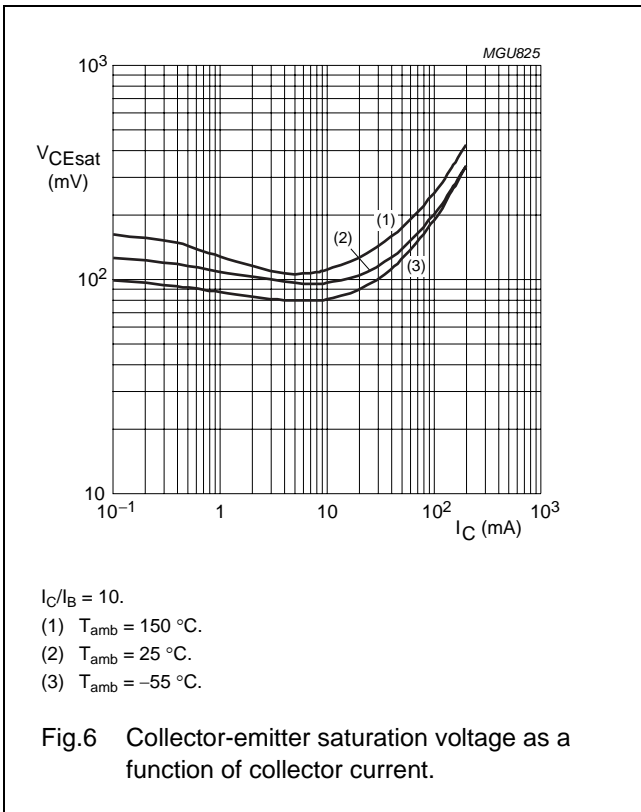
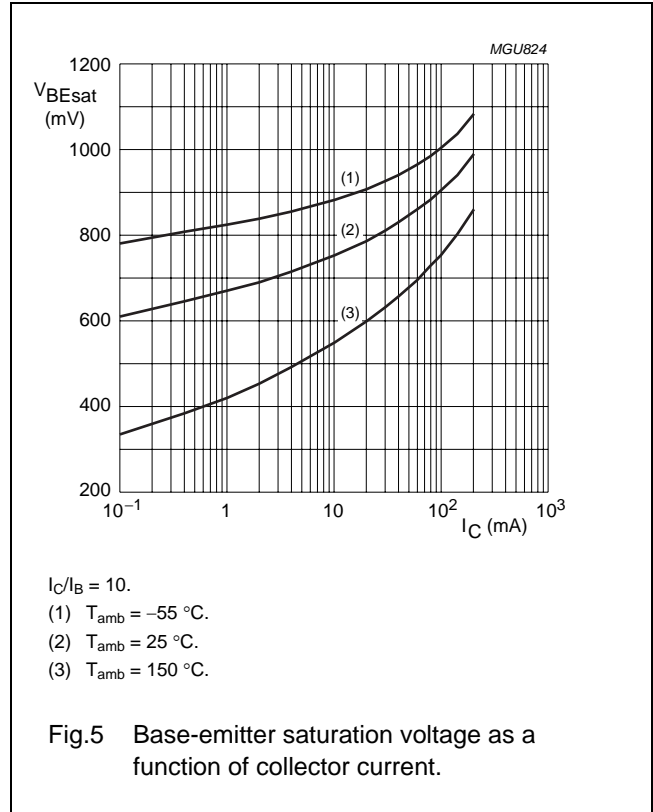
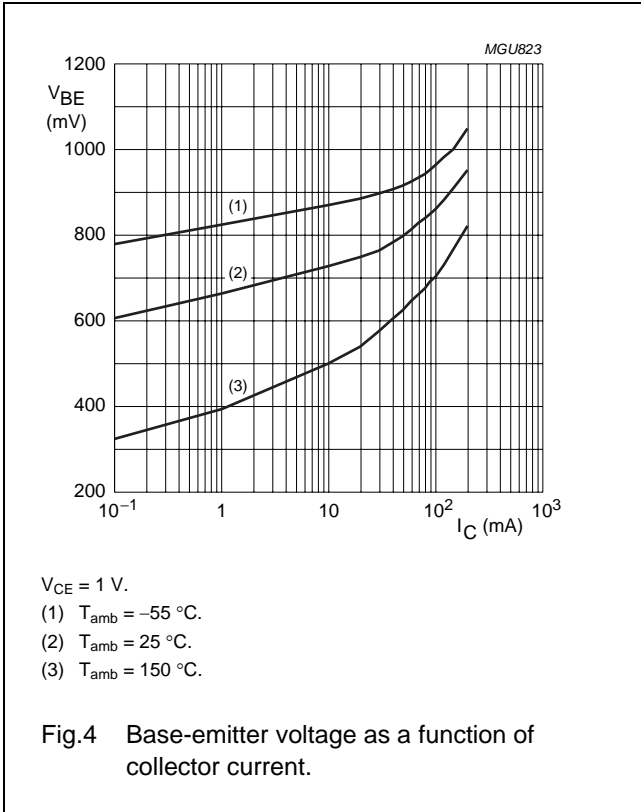
Note

1. Pulse test:  $t_p \leq 300 \mu\text{s}; \delta \leq 0.02$ .



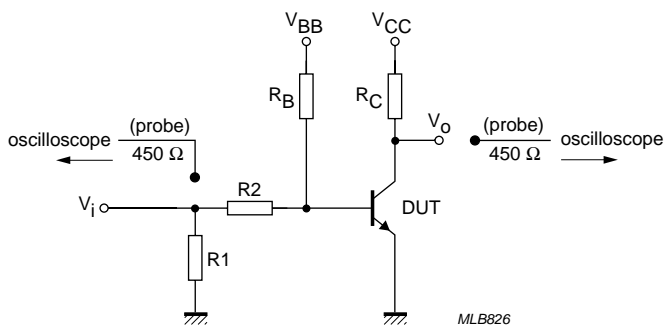
NPN switching transistor

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$V_i = 5\text{ V}$ ;  $T = 500\ \mu\text{s}$ ;  $t_p = 10\ \mu\text{s}$ ;  $t_r = t_f \leq 3\ \text{ns}$ .  
 $R_1 = 56\ \Omega$ ;  $R_2 = 2.5\ \text{k}\Omega$ ;  $R_B = 3.9\ \text{k}\Omega$ ;  $R_C = 270\ \Omega$ .  
 $V_{BB} = -1.9\ \text{V}$ ;  $V_{CC} = 3\ \text{V}$ .  
 Oscilloscope: input impedance  $Z_i = 50\ \Omega$ .

Fig.7 Test circuit for switching times.

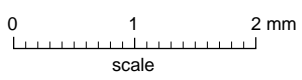
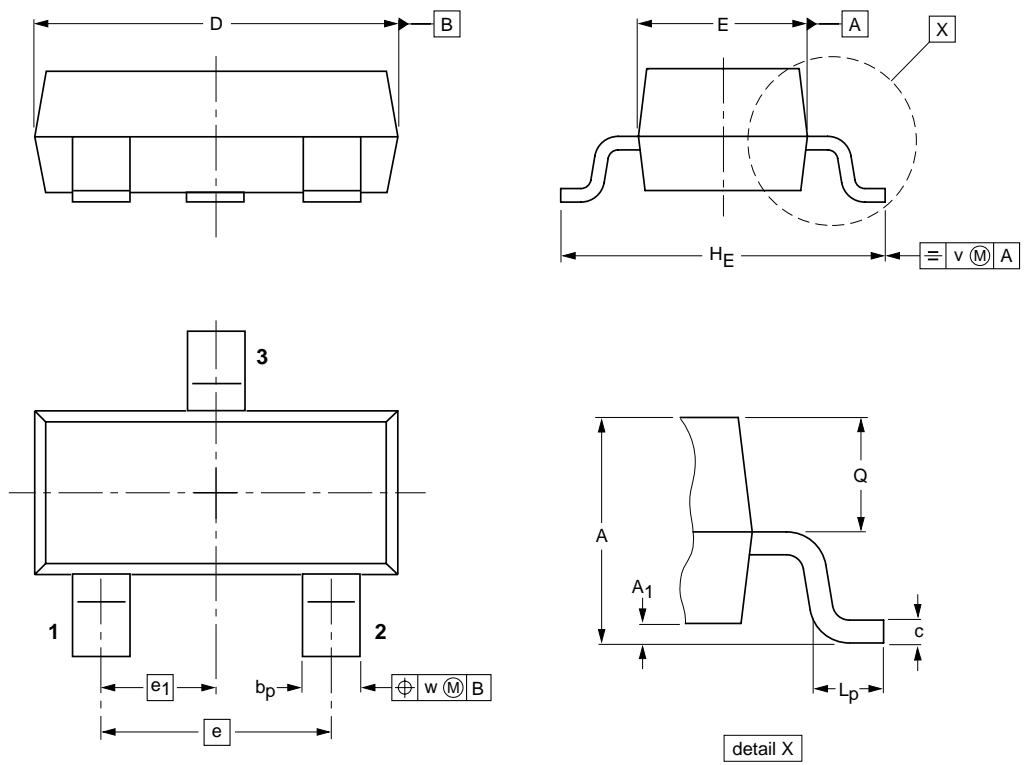
NPN switching transistor

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PACKAGE OUTLINE

Plastic surface-mounted package; 3 leads

SOT23



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub><br>max. | b <sub>p</sub> | c            | D          | E          | e   | e <sub>1</sub> | H <sub>E</sub> | L <sub>p</sub> | Q            | v   | w   |
|------|------------|------------------------|----------------|--------------|------------|------------|-----|----------------|----------------|----------------|--------------|-----|-----|
| mm   | 1.1<br>0.9 | 0.1                    | 0.48<br>0.38   | 0.15<br>0.09 | 3.0<br>2.8 | 1.4<br>1.2 | 1.9 | 0.95           | 2.5<br>2.1     | 0.45<br>0.15   | 0.55<br>0.45 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES |          |       |  | EUROPEAN PROJECTION | ISSUE DATE           |
|-----------------|------------|----------|-------|--|---------------------|----------------------|
|                 | IEC        | JEDEC    | JEITA |  |                     |                      |
| SOT23           |            | TO-236AB |       |  |                     | 04-11-04<br>06-03-16 |

NPN switching transistor

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DATA SHEET STATUS

| DOCUMENT STATUS <sup>(1)</sup> | PRODUCT STATUS <sup>(2)</sup> | DEFINITION  |
|--------------------------------|-------------------------------|---|
| Objective data sheet           | Development                   | This document contains data from the objective specification for product development. |
| Preliminary data sheet         | Qualification                 | This document contains data from the preliminary specification.                       |
| Product data sheet             | Production                    | This document contains the product specification.                                     |

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